

L-5 NEWS

A Newsletter from the L-5 Society
Number 9 * May 1976

VAJK ADDRESSES CLUB OF ROME

"Bicentennial Horizons: A Club of Rome Symposium on Systems Science and America's Next 100 Years," was held April 23-25 in Carbondale, Illinois. Peter Vajk, a physicist with Science Applications, Inc., presented "An Open Door for a Closed World" in a panel discussion held the last day of the conference. Others on the panel were Irvin Lazlo, who is helping prepare the next report of the Club of Rome, Alexander King, a member of the Executive Board of the Club of Rome, George Land, author of "Natural Qualitative Growth," and Roger Wescott, author of "The Divine Animal."

Vajk outlined the concepts of large scale habitation and utilization of space, noting that "The statement 'We have only one Earth' is radically different in its implications from the assertion 'We have only the Earth.' The former recognizes the uniqueness and sacredness of the Earth and its biosphere among the other heavenly bodies; the latter denies the existence, for any practical purpose whatsoever, of the rest of the universe, and, it seems, has now become as obsolete and outdated as the view of the Earth as the center of the universe."

John Whiteside of the Committee for the Future moderated the panel discussion. The L-5 News offers its thanks to Whiteside and the CFF for their work in arranging Vajk's Club of Rome presentation.

Vajk is the author of "Space Colonies, Ethics and People," *CoEvolution Quarterly*, Spring, 1976, pp. 66-71, and "The Impact of Space Colonization on World Dynamics," in press, *Technological Forecasting and Social Change*, 1976. Those who would like copies of his "An Open Door for a Closed World" should write to the L-5 Society. Copying and mailing expenses will be \$1.50 each; contributions to cover our expenses will be appreciated.

BIS CALL FOR PAPERS

The British Interplanetary Society has requested papers on space habitation/industrialization for a proposed special issue of their journal, *Spaceflight* Topics of special interest to the BIS are the astrodynamics of space transportation, utilization of lunar materials, construction of large structures in space, environmental control and food production, and space power systems.

Those with papers to submit should contact R.C. Parkinson, 33 Langdon Ave., Aylesbury, Bucks., England, U.K.

AUSTRALIANS JOIN POWER SATELLITE PROJECT

Twelve Australian scientists will be working with NASA on solar power satellites. They will attend an initial feasibility study at NASA's Mission Control Center in Houston, Texas, where they will consider a plan to build power satellites using lunar materials. NASA scientists have calculated that it will be fifty times cheaper to obtain building materials from the Moon than to launch them from Earth.

David Mark of Melbourne University's geology department told the Australian press that NASA is considering solar power satellites because of "last year's energy crisis and doubts about the U.S. nuclear power program." He added, "It won't happen this decade, but I don't see why we could not have solar power from space before the turn of the century."

SENATE COMMITTEE OBJECTS TO BUDGET SNAFU

The Senate Aeronautical and Space Sciences Committee has severely criticized the Executive Branch for its oversight in deleting \$5 million in solar power satellite funds from the NASA budget without transferring them to ERDA.

"The Committee notes with considerable dismay the handling of funding for NASA energy initiatives directed to this vital national need," the Committee report said.

Under a June 23, 1975, agreement and several cooperative projects, ERDA is responsible for terrestrial applications of energy research. The \$5 million sum was supposed to be under ERDA administration, but research was scheduled to be carried out by NASA on a reimbursable basis.

"ERDA, however, apparently due to time constraints in finalizing the budget, did not provide an equivalent amount in its budget," the Senate committee report said. "While this omission is unfortunate, the committee is greatly disturbed by the apparent inability of the Executive Branch to correct the deficiency promptly so as to continue to apply these capabilities to the national energy problem.

"The committee is of the view that for the nation to be able to tap the potential contributions of all agencies to the problem of energy self-sufficiency, these agencies, including NASA, should not only be permitted but also encouraged to use nominal amounts of their regular resources to identify, and verify to some extent, possibilities which would be presented to ERDA for evaluation against competing alternatives and for subsequent funding as appropriate."

For those who don't understand bureaucratise, this means that the Committee feels that NASA should be allowed to spend "seed money" such as

the proposed \$5 million in solar power satellite funds, in order to research early-stage energy projects. Once such a project reaches the stage that a large-scale financial commitment is required, then it would be ERDA's responsibility to evaluate and fund it.

The Senate Committee also pointed out that it is the responsibility of the Executive Branch to straighten out the transfer of funding from NASA to ERDA. This transfer is required by the Energy Reorganization Act of 1974. It called upon the Executive Branch to "assure that budgeting responsibilities are conducive to an aggressive and effective energy research and development program."

HELP!

The L-5 presentation at the U.N. Habitat Forum represents a unique opportunity for the Society to bring the space communities concept before the world press.

Pat Ellis of Concepts Consultants, a member of a Vancouver group disseminating space colonization information, is setting up media interviews for the L-5 team of physicist Peter Vajk, anthropologist Magoroh Maruyama, and science writer Robert Wilson. The New York Metropolitan L-5 Chapter is providing models of the Stanford Torus and O'Neill cylinder habitats for use at the Forum.

Kerry Joels, of the United Nations Environmental Program and Assibi O Abudu of the Economic Planning Council of Ghana have been most helpful in advising the L-5 team on how to best present our concepts to a world audience.

(Economist Abudu's contribution to the debate on the military implications of satellite solar power stations will appear in the next issue.)

On the financial front, Vancouver space habitat enthusiasts will provide housing and meals for the Society team, greatly reducing our costs.

Since the last issue of the L-5 News, which reported \$750 raised, we have received only an additional \$36 for the Forum fund. Out thanks to those who contributed, but we must have another \$964 to go there.

The Society's work is financed solely by contributions from individuals. We have no industry support (although we wish we did!)

If you feel that this proposed presentation to a worldwide audience is a project which will advance our goals, please tell the Society with your checks! Donations are tax-deductible.

Send donations to Habitat Fund, L-5 Society, 1620 N. Park, Tucson, AZ 85719.

The Forum starts May 23; we must know by then what the financial status of the project is so we can cancel it if necessary. Please call us, (602) 622-1344, if you plan to contribute.

MILITARY ASPECTS OF SSPS POWER

Keith Henson

In a *Wall Street Journal* article, "War Changes Faster than Experts Predicted," April 15, 1976, there appeared this statement:

"An Air Force general thinks an answer to such threats (missile attacks by terrorists and small powers) may lie in high-energy laser weapons, based in space, capable of destroying missiles with thin, powerful light beams. The Pentagon is spending some \$200 million a year to develop more powerful lasers."

It is with considerable reluctance that *L-5 News* opens discussion of this subject. However, it is clearly a concern for those interested in space colonies. Also, readers may have some suggestions on how to guide developments in a peaceful way.

Due to the low energy density of the SSPS microwave beam, it could never be considered a weapon. There is no way to increase the energy density to dangerous levels without massively larger transmitting antennas. Diffraction effects limit the concentration of the power beam to an angle (in radians) of $1.22h/D$, where h is the wavelength, and D the diameter of the transmitting antenna (Airy's disk). At the distance of the Earth from geosynchronous orbit (37,500 km) the power beam from an SSPS will spread to at least 4 km in diameter if h is 10 cm and D is 1 km. If the wavelength is reduced to 10μ , however, the beam diameter would be 0.4 m, assuming the same transmitting aperture. In reality, a much smaller aperture, and less than perfect optics, would probably increase the beam diameter to several meters.

Carbon dioxide lasers operate at 10.6μ and are about 20% efficient. It seems possible to scale them up to very large sizes. If so, a 10 Gw SSPS could put 2 Gw into a laser beam. The equilibrium temperature in the center of the beam would be far above the vaporizing point of any material.

While this could be used against targets on the ground and in the air, we already have plenty of ways to lay waste to the countryside and blast planes out of the sky. It is the antiballistic missile aspects that interest the military.

Ground-based lasers for missile defense have been under study for several years. There are several very difficult problems associated with sending the laser beam up through the atmosphere, much like trying to shine a light up from below the surface of a pond. This problem does not exist for space-based lasers. The problems of hitting targets near the Earth from high orbit are formidable also, but over the time period necessary for SSPS development could probably be solved.

I will leave it to the think tanks to consider the various scenarios involving the covert conversion of an SSPS to a defensive weapon.

What would be the reaction of any major power to one of the other powers building a defense of this kind?

I think this consideration is one of the strongest arguments for space industrialization to be an international project.

L-5 News would like to hear from readers on this subject, both on the technical problems, of which there are plenty, and on the moral and political issues. There has already been one excellent response, which will be printed in next month's *L-5 News*.

NEED TO EVALUATE FEASIBILITY OF SPACE-BUILT SSPS

Richard C. Sklarew, and J. Peter Vajk, *Science Applications, Inc.*

The concept of satellite solar power is based on using the sun's energy above our atmospheric blanket to produce electricity which can be transmitted for use on earth.

The sun is the ultimate source of renewable energy. Above the blanketing effects of the atmosphere and without the day-night cycle, the available energy from the sun is fifteen times as great as on the ground in the United States. The conversion of sunlight to electricity in space is possible using present technology such as focusing the sun for turbo-electric generation or using photovoltaic solar cells. The energy can be transmitted to the earth's surface via microwaves similar to the present communications satellite transmissions. Then on earth the microwave beam can be converted to high voltage electricity and added into the power grid.

The satellites used for power production must be large to take advantage of economies of scale. Initial systems are designed for five to ten thousand megawatts with each satellite weighing four to fifty thousand tons. The satellite can be built from materials brought up from the earth's surface or from extraterrestrial raw materials. The earth-launched development alternative makes use of earth's existing industrial complex but requires reallocation of our terrestrial resources, high launch rates through the atmosphere with its possible environmental damage, and the monetary and energy costs of climbing out of earth's deep gravity well.

The "space-built" alternative, using extraterrestrial resources, alleviates the reallocation of earth resources and the environmental impact of launching but requires development of a full industrial complex in space: mining the moon for raw materials, extracting the necessary elements, and fabricating the assemblies. Preliminary assessments have indicated the space-built system could begin with busbar electric costs of \$.015 per kilowatt-hour (compared with our present \$.015-.018 per kilowatt-hour nationwide

average) and could lower costs rapidly, the total generating capacity could increase exponentially, and the system could repay its initial capital investment within fifteen to twenty-five years.

The capital costs for additional generating capacity would be ten times cheaper than present systems, approximately \$60 per kilowatt. Feasible space-built systems based on current technology could be providing the total United States requirement for new electrical generating capacity in the 1990s. The same space industrial complex developed to build the power satellites could also use extraterrestrial material to build any and all the other industrial products required on earth. These space products could be transported to anywhere on the earth's surface by non-polluting space-built freighters.

Either alternative has advantages as well as disadvantages. The potential return from the satellite solar power system as well as the required investments are so large that the proper alternative must be determined, researched, and thoroughly planned. Such a program should be begun at once. World dynamics modeling pioneered by Forrester and Meadows under the sponsorship of the Club of Rome has suggested that the resources required for an undertaking such as a satellite power system will *only* be available in the near future after which we will no longer have the capacity to tap extraterrestrial resources and open the closed system and finite resources of our spaceship earth.

A-STROLLING O'ER THE ASTROTURF THE ARTIFICIAL ENVIRONMENT OF A SPACE COLONY

T. A. Heppenheimer

Among the most frequently-voiced objections to space colonization is the following: "Wouldn't it be simply dreadful to live in a totally artificial environment, with nothing there that is the work of Nature?"

Space colony buffs usually try to answer this by stressing the care and attention to be given to architectural design, to the importing of trees and greenery. Yet there are plenty of nature buffs who will not be appeased, who would never be satisfied with anything less than that original space colony, the Earth. They argue that people will be harmed psychologically by the artificiality of the environment. So it is necessary to examine critically the question of the greening of a colony.

True, colonists may miss the mountains and fields of their earlier days; they may find the colonies' substitutes to be wholly inadequate. They make frequent jokes about the efforts of the architects to beautify (some, perhaps, will say "uglify") the colony.

This does not mean that they will be

psychologically harmed. Psychological harm or damage involves an inability to form satisfactory relationships with other people, or to work productively. People have made adequate adjustments, have lived happily and productively, in Nazi Germany and in Stalin's Russia, in Outer Mongolia and even in downtown Los Angeles. People are flexible and resourceful, and are very good at getting along with what they have.

The reader by now may have guessed that I have substantial doubts as to just how natural the colony environment can be made. So I am not going to try to defend the proposition that the architects of that vast bureaucracy, the Space Industrialization Administration, will in fact be able to conjure up visions of the New England of Robert Frost.

Instead, I will suppose the opposite: they will produce pleasant, attractive residential areas; they will indeed use real grass rather than Astroturf; but the colonists will forever be chuckling over their so-called waterfalls and "natural" rock formations of concrete.

This leads to the question: what difference does it make?

The criticisms and fears as to the effects of this tend to come from people with a well-developed affinity for the land. These are artists, academics, and writers with ample opportunity to indulge a taste for backpacking in the Adirondacks or long strolls in solitude along the dunes of Cape Cod. For these people, to be sure, life in a space colony would be a definite step down.

But there is another and rather more numerous type of person, who lives somewhat differently. A typical individual of this sort would be a construction worker who lives with his wife and kids in an apartment in the Bronx.

He commutes by subway to work on construction sites in Brooklyn and Queens. He thinks the Adirondacks are in South America, and on his days off he sometimes takes the family to Bradley Beach, where there is all the solitude of a seal rookery.

For this construction worker, a space colony would be a definite step up. The living conditions would be much more pleasant than he is accustomed to. Even Astroturf would be an improvement over those works of nature found on New York's streets-dog droppings.

There would be no more noisy, crowded subways, and he would appreciate the weightlessness of his work environment, where he would be free of the danger of falling from a girder, thirty stories over Flatbush Avenue.

These observations are not new, but are very old. The settled, the affluent, the satisfied, the smug-these have never settled the world's new lands. On the contrary, they have always stayed at home, wondering that anyone should ever want to live in a land where there was no Parthenon or Canturbury Cathedral. It

was these people, in centuries past, who led the scoffing at the rude manners of those oafish American settlers, or who sneered, "Who reads an American book?"

It has always been the adventurous, the ambitious who have settled in colonies. It has been those who felt their opportunities to be limited, their societies to be too stratified to allow them the opportunities they sought. Many of them gave up far more than cathedrals or lonely beaches to seek their frontiers. Some, indeed, grew discouraged and went home. Most did not, and stayed to build their new societies.

In this connection, it should be stated that the colonies in space will indeed be true frontier societies, in the sense of the kibbutzes of Israel or of the Massachusetts settlements of the seventeenth centuries. Far from being psychologically damaging, such societies are among the healthiest places for children to grow up. Such children will rarely suffer from anomie, or rootlessness, or alienation. From their earliest years, they will be cherished and valued, in a society with much work to do and few people to do it. Even in their childhood play, they will learn attitudes and skills of value to their lives as colonists, the way children in the old West learned of horses.

It is from precisely such societies, such frontier communities, that established civilizations have received a disproportionate share of their leaders.

Beyond this, a space colony will offer an entirely new natural environment, not of rivers or hills, but space itself.

It will be a simple matter to devise a type of small personal spacecraft, perhaps resembling a pressure-tight Chevy van. It would be equipped with small rockets, to achieve moderate speeds (a hundred miles per hour, say), along with an alarm to warn when fuel was getting too low for safe return. In such a craft, built perhaps with large wraparound windows, space colonists would frequently experience the profound vastness and beauty of space.

The sky in the desert is beautiful. It is a magnificent thing to be alone on a mountaintop. Yet these experiences may pale in comparison to the starry overwhelm which will be a colonist's common experience.

The colonists' lives, their world-views, ultimately their art and literature, all these will reflect that overwhelm, to a degree difficult for us to now perceive. One may think of the world's seafaring peoples, of those who have wrested livelihoods by fishing or trading on the oceans. It is these who have evoked for us the meaning of the human experience with the sea. We are all of us in their debt, even if we never know the ocean save from the deck of a cruise ship.

Through their lives and their thoughts, they have enriched our common heritage.

There will be new experiences for the human race, new insights, new poetry,

and much of this will be strange to us. People of the mountains have often found it difficult to comprehend the views of people of the open range or of the desert.

It may be hundreds of years before we can comprehend the significance of this simple statement: the space colonists will be a people of space.

RADIOACTIVE MATERIALS IN SPACE

NASA has proposed to ERDA that radioactive wastes from nuclear reactors be stored in high-lifetime orbits, according to Jesco von Puttkamer, of NASA's Office of Space Flight.

"We are offering to the nation a future choice of storing these materials in orbit for an added cost of perhaps one mill per kilowatt-hour," he stated.

"Whether the public would be willing to pay this price (about 5% of current electricity costs) for added safety of waste disposal is uncertain," he added.

Because we might find uses for the waste materials at some future date, von Puttkamer felt that it would be unwise to "throw away" radioactive wastes by either dumping them into the sun or sending them out of the solar system. "You would always track where nuclear waste packages are in case they become valuable."

With regard to the possible dangers of scattering these wastes due to accidents while transporting them to orbit, von Puttkamer replied, "We have flown nuclear payloads into space several times, including the Apollo moon missions. They were designed to take impact. I was on the reactor safety design team, by the way."

He recalled the aborted Apollo 13 mission: "The Lunar Landing Module (which contained a nuclear power source) sank into the sea. The nuclear capsule never opened. Uncounted smaller satellites have been flown with nuclear power sources."

UN SPACE CONFERENCE

The Scientific and Technical Sub committee of the United Nations Committee on the Peaceful Used of Outer Space met in Geneva, March 22 - April 9.

One of the U.S. delegates has reported that the subject of space colonization was not raised in the plenary sessions, but was discussed on more than one occasion in the working groups. The consensus was that it is an interesting idea but is too far off to be as relevant as some more immediate concerns. The Society's understanding is that it will not appear in the written record.

The decision on the U.S. position on space colonization must be made by Arnold Frutkin at NASA, who is the key to the U.S. views on space presented at U.N. and other international meetings.

NUTS AND BOLTS ENGINEERS HEAR SPACE COLONY PAPERS

William M. Agosto

Five well-known space-work enthusiasts spoke to an audience of about two hundred mechanical engineers last month at the 1976 Design Engineering Conference in Chicago, sponsored by the American Society of Mechanical Engineers. The occasion was a plenary session of Future Design Problems in Space Colonization, organized by electronic engineer William Agosto.

Gerald Driggers of Southern Research Institute, who chaired the session, set the stage for the sober audience with the projected montage of a planet, a high-orbit tug, and a bag of extraterrestrial rocks, gleaming in cosmic sunlight. It looked like Joan Miro, a post-impressionist light show that helped Driggers put across the basics of space industrialization-transporting and working extraterrestrial materials in an energy-intense space environment.

Richard D. Johnson of NASA-Ames Research Center gave an overview of space colonization concepts that have come out of the 1975 NASA-Ames Summer Study, which he co-directed with Gerard K. O'Neill. He described the heavy radiation-shielded Stanford Torus, with its three-mile circumference, one RPM rotation rate, and remote power sources. He discussed proposed space ecosystems, including details of closed-loop recycling and waste treatment processes. For Johnson, the large earth-like O'Neill cylinders are a century off, but he presented a colony construction time-table that would put up three prototype habitats and associated space manufacturing facilities in thirty years. Payback to Earth would be achieved four years later with electric power from space produced solar power plants.

Martin H. Bloom, Professor at the Aerodynamic Laboratories of New York Polytechnic, discussed space mechanical fabrication with extraterrestrial resources emphasizing new applications of established techniques to capitalize on weightlessness, vacuum, and high radiant energy of the space environment. He pointed out that Earth-based habits of design, like elaborate low-friction bearings, might be abandoned for totally new approaches to coupling moving space parts.

K. Eric Drexler, of MIT, summarized space processing all the way from food production to conversion of moon rocks into structural materials. He stressed the economic importance of high productivity and high ratios of extraterrestrial raw materials to Earth-launched mass, and outlined continuous carbochlorination processes that could produce high yields of metals and oxygen from lunar ores, while recovering reactants like carbon and hydrogen that are rare on the Moon. He finished with a preview of space vapor

fabrication of high-strength metal sheets by evaporating metal charges with a solar furnace.

William N. Agosto talked about space production of satellite solar power stations from extraterrestrial materials. He showed how O'Neill's space manufacturing proposals could make the huge Earth-orbiting power plants economical by radically reducing Earth launch expenses. He outlined electro-optical techniques that could resolve problems of scale, such as that of accurately pointing the microwave power beam over the 22,000-mile distance from geosynchronous orbit to the Earth antenna array. He discussed a time-table that came out of last year's NASA-Ames Summer Study. It projects all new and replacement U.S. electric generating capacity as SSPS-derived by the year 2000, at bargain rates (less than twenty mills per kilowatt-hour). Even that scenario is projected to cost only one-tenth the cost of the \$2 trillion proposal by Presidential candidate Henry Jackson for more conventional U.S. energy development over the next fifteen years.

Several standard questions were fielded from the floor, such as "When will the first SSPS be up?" Gerald Driggers answered that both space manufacturing and Earth-launch proposals envision emplacement of an operating prototype that delivers about 1 Gw in the early 1990s.

All-in-all, the session was a professional presentation of technical problems and proposed solutions to a professional audience that made space industrialization seem as down to earth as the acres of hardware on display in the adjoining exhibition hall.

A version of Bill Agosto's remarks is published in the May 1976 issue of *IEEE Spectrum*.

BICENTENNIAL EXPOSITION ON SCIENCE AND TECHNOLOGY

The United States' only government-sponsored exposition during the Bicentennial year is taking shape at the Kennedy Space Center in Florida. Scheduled to be open May 30 through Labor Day, the exposition will show the role science and technology are playing in improving the quality of life in America.

Sixteen Federal agencies and approximately a dozen industries are combining forces to give visitors a glimpse of "Third Century America." President Ford envisions the exposition as an opportunity for Americans to "see the best in America" not only from the past, but what is to come in the future. "It is a team effort that I think the American people will greatly respect and thoroughly enjoy," Ford said.

L-5ers will be interested in the displays at the Exposition which have been developed, under the coordination of the Advanced Programs Office of NASA, by

NASA's Johnson Space Center, Marshall Space Flight Center, Ames Research Center, and Jet Propulsion Laboratory, in conjunction with the Aerospace Corp.

The four future space themes, Solar Power from Space, Space Applications to Daily Life, Industrial Expansion into Space, and Space Colonization, are combined in the Advanced Programs Exhibit located in the High Bay Transfer Aisle of the Vertical Assembly Building.

A COMMUNITY IN SPACE

On July 11-15, 1976, The Institute on Man and Science will convene a public forum on its campus in Rensselaerville, New York, to grapple with the social, economic, and human issues of planning a new habitat in space. Program chairman will be Dr. Isaac Asimov, biochemist and renowned author of over 175 books. Also included on the faculty are Ben Bova, editor of *Analog* magazine, and Dr. Bert E. Swanson, co-author of the Woodrow Wilson Award-winning book, *The Rulers and the Ruled*.

The program's point of entry will be the ideas set forth on the subject by Dr. Gerard O'Neill. To date, the proposed specifications of a space colony have been suggested by experts. But how would prospective residents go about planning the community and industry in which they would live and work? This program is designed to find out.

Seventy resident participants will be accepted, and up to fifty additional people can be accommodated as commuting participants. Included will be teachers, students, business persons, and citizens from a broad range of professions and vocations. The intent is to form a diverse and informal learning community.

For further information and/or registration materials, contact Ms. Terri Rapoport, Public Programs Coordinator, The Institute on Man and Science, Rensselaerville, NY 12147; (518) 797-3783.

L-5 DIRECTOR SPEAKS AT ALTERNATIVE ENERGY CONFERENCE

Keith Henson, a Director of the L-5 Society, gave a presentation, "Solar Energy from Space," at a conference on Alternative Energy Sources in St. Paul, Minnesota, April 27. He was on a panel with Peter S. Van Nort, General Manager, Project Management Corp., Oak Ridge, Tennessee, who discussed the liquid metal fast breeder reactor; and Jefferson O. Neff, Technical Assistant to the Director of Controlled Thermo-nuclear Research, ERDA, who discussed fusion power developments.

The audience responded enthusiastically to Henson's lecture. Let's face it, power from space has an element of adventure lacking in other energy proposals.

HORIZONS DAY UPDATE

Lindy Boggs, chairperson of the Joint Committee on Arrangements for Commemoration of the Bicentennial has sent a letter to all members of Congress asking them to request their local Bicentennial Committees to hold Future Day Assemblies on Horizons Day, June 26.

The purpose is to create a national state of awareness of our responsibility for the future. Those interested in Participating in Future Assemblies should call The Committee for the Future, toll-free, (800) 424-2488.

BIBLIOGRAPHY UPDATE

Materials Processing in Space Newsletter

This newsletter is produced by the Universities Space Research Association as part of the NASA Space Processing Program at Marshall Space Flight Center. Two issues have been brought out to date. To receive the newsletter, write Prof. Henry Leidheiser, Jr., Center for Surface and Coatings Research, Sinclair Laboratory Bldg. No. 7, Lehigh University, Bethlehem, PA 18015.

Grumman Aerospace Horizons

This is a slick, full-color magazine, published by Grumman Aerospace Corp., Bethpage, NY 11714. Volume 12, No. 2, contains an article, "Space Solar Power - An Available Energy Source," pp. 8-19, including a full-color foldout. The photo-voltaic method of energy conversion is discussed.

Manned Orbital Facility: A User's Guide

Write to C. C. Priest, PS04, NASA, Marshall Space Flight Center, Huntsville, AL 35812.

National Space Institute Newsletter

Volume 1; No. 3, March 1976, is devoted to space colonization. Write NSI, Suite 408, 1911 N. Fort Meyer Dr., Arlington, VA 22209. Membership is \$15 per year (\$9 per year if under 18).

LETTERS

I think the view of the Society regarding space colonization needs further development. The idea that space colonies could reduce the cost of power satellites may be true, but an adequate study to resolve this question has never been done. The statement that space transportation beyond the Shuttle is not required indicates to me a lack of appreciation of the magnitude of the transportation tasks associated with something of the magnitude of colonization; the associated implication that no significant developments are required is absurd. The linking of power from space and space colonization as presented by the Society is just possibly inimical to both and certainly too narrow a view.

From today's vantage point, our understanding of the true long-range reasons for space colonization is probably

similar to the views of colonization of the New World as seen from sixteenth century Europe. The principal view was to go steal gold from the Indians. In fact, getting power from space is vaguely analogous except that we don't have to steal from anyone. There were naive views of the easy life in idyllic settings; in fact the early colonists had a rough time, ravaged by disease, inadequate supplies, and occasionally hostile natives.

Some colonies were established by deliberate deportation (Australia) or enthusiastically-tolerated emigration. The real value of colonies began to emerge with the establishment of the British colonial empire: resources, markets, trade, military bases.

It seems to me that space colonization may evolve in a manner somehow similar to Earth colonization:

Utilization of near-Earth (including the Moon) space for "commercial," i.e. practical, purposes will evolve and expand. Potentials include communication, observation, manufacturing, and space-based power. These can all be grouped under the term "space industrialization."

As these activities expand and the cost of transportation comes down and we learn more about long-term space habitation by man, economic benefits of providing for permanent space residency are likely to motivate a trial, at least on an experimental basis. Unlike, O'Neill, I think the Moon is the most likely site for early colonies, primarily because of the availability of radiation shielding material. Populating an area the size of the Moon might be expected to take something like two centuries; there is also Mars, given some improvements in space transportation capabilities. "O'Neill Islands" can come along as the technology matures; they may have to compete with, or perhaps serve as the vehicles for, interstellar travel.

When a really effective space propulsion capability (fusion?) is developed, it may become practical to mine the asteroids or moons of the outer planets for minerals, metals, and volatile gases (nitrogen, hydrogen). The latter will be precious on Moon or Mars colonies or O'Neill Islands built from lunar materials.

The use of extraterrestrial raw materials on Earth seems to me unlikely as the cost of transportation will probably always exceed the cost of extraction from even very poor ores. There may be exceptions in the case of rare and valuable materials, and it certainly does not, in my opinion, apply to manufactured products.

As populations in space grow to significant levels, the flow of trade and commerce (and tourism?) will increase. Natural planets with external atmospheres may be bypassed by much of this due to the limitations the atmospheres place on effective transportation.

All of our present thinking,

evaluations, and concepts of space utilization and colonization would have to be revised if a truly effective transportation technology were devised. Here I am thinking of a nonreactive system. Reactive systems must either carry a great reaction mass (low specific impulse) or spend a great deal of energy getting a lot of thrust from a small reaction mass (high specific impulse). In either case, the ration of energy expended to that imparted to payload is large. The lunar-based mass driver is such a nonreactive system, provided that the mass driven is the payload. If the mass driver is used as a rocket, it suffers the same limitations as any other reactive system.

Nonreactive systems of the type often envisioned by science fiction writers or UFO enthusiasts are quite beyond the ken of our physics today, but may be possible for some future physics. The potential value thereof may be seen by noting that the value, at typical present-day high-grade (electricity) costs, of the energy residing in an object in geo-synchronous orbit, relative to Earth's surface, is about 50¢ per kg, compared to costs of placing payload in that orbit even by very advanced reactive systems over 100 times greater.

Gordon R. Woodcock
Bellevue, Washington

Sorry to disappoint you, but I must tell you that I have absolutely no interest in your project. It seems strange that we always think we're going to "solve" the problems that we have created with our white man's eco-technology . . . by larding a heavier load of white man's eco-technology onto the very natural systems that you claim to admire and respect.

I think that we can all accomplish a great deal more by *really* sitting down and paying attention to the damage we have done. . . rather than trying to run off and create new and bigger damage.

John Shuttleworth
Editor-Publisher
Mother Earth News
Henderson, NC

P.S. Some of the wisest old cultures of the planet have repeatedly warned against the idea of space colonization. You might be interested in going back and rereading the interview with the traditional Hopi Indian spokesman that we ran in a very early issue.

An intrepid L-5 staffer found the article to which Mr. Shuttleworth refers. Relevant excerpts follow:

"Mankind is now used to modern conveniences and modern methods of transportation. . . . Progress is booming in every field of scientific and technical knowledge. We tend more and more to just make money and destroy Nature along with it. . . .

"Soon we'll just go all out and men without control become forces for evil.

They do not listen to any good thoughts or words. They openly do things that everyone knows are wrong just because they're proud. . . .

"The older people knew this and spoke of a day when man would disrupt the moon and the stars. They knew that this would be almost at the last days before the Purifiers would come to clean up the mess here. Our elders said that if we ever bring something down from the moon that it will disturb Nature very strongly and that many things will happen from there. . . .

"They [the Purifiers] will come here quickly one day and just paralyze this earth. All the power that we have-the machines and everything-will stop and they will conquer the land. . . .

"We know that the time is getting close because every Hopi prophecy of warning but one has been fulfilled. The only thing that's left is the fulfillment of a huge house that carries many people that will be floating in the sky. This will be the last thing that mankind is allowed to do. If mankind goes that far, it will completely destroy Nature unless it is stopped."

The Mother Earth News, No. 12
November, 1971
The Plowboy Interview:
Tom Bauyacya

I should like to thank you for including the item about my joining the L-5 Society in the March issue (though I blush at the 'Famous International . . .'), but I feel that I should correct a statement which I believe was due to a misunderstanding by the U.K. branch editor. To my knowledge, at any rate, Dr. Tom Paine does *not* own one of my space paintings (though I would be delighted to do one for him-or anyone else connected with the space programme!). Dr. Wernher von Braun does, as stated, as do Arthur C. Clarke, Dr. Carl Sagan, Dr. Isaac Asimov. . . .

In addition to painting I also write; a new children's book which I have written and illustrated, *Rockets and Satellites*, is due out here in May. It is my intention to write a book for children about space stations and space colonies - in other words, to express the aims of the L-5 Society in easily-understood terms. Some authors may look down on writing for children, but my motto is 'catch 'em young'; after all, today's kids of nine or ten are the people who will be (hopefully) putting up the money for the space projects of the 1990s - or even working on them.

However, I am finding some difficulty in collating all the information available and finding out what, apart from the Shuttle, are 'real', funded projects and what are mere ideas in some writer's head. I also need as much material as I can obtain for illustrations-preferably not other artist's impressions, but fairly simple engineering-type drawings which I can throw into perspective and bring to life myself. Any help which members can

supply will be most welcome, and thanks in advance.

David A. Hardy
99 Southam Road, Hall Green
Birmingham, B28 OAB,
England

The Spring '76 issue of *CoEvolution Quarterly* devotes 66 pages to in-depth comment on space colonies by some 67 people-architects, astronauts, biologists, financiers, philosophers, physicists, etc. Some of the most interesting comments are by critics. The ones I found most cogent are as follows:

-A functioning biosphere of the kind planned for a space colony requires large quantities of the compounds of nitrogen, hydrogen, carbon, and phosphorus, all elements rare on the moon. Is it economically practical to lift sufficient quantities of these elements out of earth's gravity well? Can they be gotten from the asteroids or other extra-terrestrial sources?

-Multi-organism biologic systems are not well understood; closed-cycle systems even less so. Experimentation is required to determine if the kind of systems contemplated for space colonies will be stable.

-A corollary of Parkinson's Law is Hitch's Rule: the final cost of large scale projects exceeds careful preproject estimates by a factor of two to twenty. If Island I ends up costing \$400 billion instead of \$200 billion it will probably still be a success. However, there is a cost limit, probably well below the \$4 trillion upper bound of Hitch's Law, where the project will be abandoned.

This sort of detailed comment and criticism is an encouraging sign; it indicates that people are beginning to accept space colonies as a viable concept and proceeding to grapple with specifics.

Dave Caulkins
Los Altos, California

The Spring 1976 issue of *CoEvolution Quarterly* is available through L-5 headquarters, 1620 N. Park Ave., Tucson, AZ 85719. \$2.50 per copy

The only bumper sticker that turns me on as being more than a play on words or an inside joke is **Space Power: L-5**.

I also suggest another: **Space: The Forever Frontier**, and I suggest a nickname for L-5 Society members. If we are "Elfivers," we are "Elves," each of us a "space elf." I hope I have made my contribution to space slang of the forever future!

Russian space-watcher Phillip Parker's excellent survey left out two important projects: a *one-year* closed bioregenerative three-man space system test already concluded, and the "Orbita" centrifuge tests, manned long-duration spin experiments.

Elves forever!

James E. Oberg
Dickinson, Texas

STEWART BRAND: OUR MAN IN THE COUNTER-CULTURE

Robert Anton Wilson

Stewart Brand, publisher of the famous *Whole Earth Catalog* and the new *Co-Evolution Quarterly*, was once a member of Ken Kesey's Merry Pranksters - a kind of psychedelic guerrilla theatre - and is now a leading advocate of Gerard O'Neill's L-5 space habitat plan.

Brand sees no contradiction between the days of the Electric Kool-Aid Acid Test and his current involvement in space migration. "The purpose of the Merry Pranksters," he says, "was scientific research on social change." Kesey's band of philosopher-clowns, in this perspective, were experimenting with the parameters of consciousness mutation.

The *Whole Earth Catalog* is virtually the Bible of the new rural dropout culture, and a whopping 1,600,000 copies of the last catalog were sold. Thousands of libertarian communes started in the sixties are now using bits and pieces of the eco-technology presented in those manuals.

Stewart Brand himself is now experimenting with an even more "far-out" concept. The Fall 1975 edition of *Co-Evolution Quarterly* devoted four articles to discussion of O'Neill and space migration; the Spring 1976 issue devotes 76 of its 144 pages to further exploration of the L-5 project.

Brand also set up a recent conference with Prof. O'Neill, California Governor Edmund G. Brown, Jr., biologist Paul Ehrlich, and astronaut Russell Schweickart (Apollo 9) to discuss L-5. The results included an endorsement of L-5 by Dr. Ehrlich, formerly a bitter foe of space migration plans, and Governor Brown's invitation to O'Neill to present his ideas to the California Energy Commission.

Brand's comment that Governor Brown is now "quite interested" in L-5 may prove significant. Brown is a contender for the 1976 Democratic nomination for President.

How did Brand's interest shift from rural ecosystems to Outer Space ecosystems? He says there was no shift; his interest has always been in "humane uses of technology."

In 1966, Brand says, an Ottawa Indian lady expressed sorrow to him when a Vanguard rocket failed. When he asked why this was important to her, she replied, "Each one of those gets us closer to home." Brand says he didn't fully understand her meaning then, and still doesn't, but the remark has always haunted him.

Brand has criticised the L-5 Society for seeing the space migration debate "simplicistically" in terms of "pro-and-anti-technology." When asked how he would define the issue, he said slowly, "I don't like either/or choices. They're too simplistic to be useful." He added

ominously that Speer's book on Hitler shows that the Fuhrer always saw everything in stark either/or categories.

He also dislikes R. Buckminster Fuller's metaphor, "Spaceship Earth," saying, "It makes the planet sound like a human artifact." In general, however, he's an admirer of Fuller's ideas.

When asked how soon he thinks L-5 will be built out there, he says, "That's like asking when a five-year-old will lose her virginity. It depends on so many factors. . ." But he added that the goal of 1990 is "possible." He believes in approaching L-5 in step-by-step increments and, like von Puttkamer of NASA (L-5 News, March 1976) favors aiming first for a space lab or work camp by 1985.

Brand is careful not to criticize the opponents of L-5. "Quite possibly true," he says of most warnings, adding, "We won't know until we have it." For the benefit of the more rigid cottage-industry types, he adds, paraphrasing O'Neill, "An advanced technology may be too dangerous for any planet. It may only be safer in space."

When asked for a specific message to the L-5 Society, Brand thought for a while and said, "They should consider carefully all that the critics say, especially Ken Kesey's warning about space enthusiasts who 'never got into the Earth.' If the migrators don't understand what the critics are warning about, a lot of mistakes will be made that don't have to be made."

HENDERSON/HUBBARD DEBATE

New York University sponsored a debate, "Values and the Future," April 23, between Princeton Professor Hazel Henderson and Barbara Marx Hubbard of the Committee for the Future. Hazel described herself as a "crisis manager" attempting to help the world make a transition toward a more equitable and holistic state. Barbara proposed that the extension of life on Earth into the universe was a natural extension of the evolutionary process.

Hazel, who had opposed space colonization in the Spring 1976 *CoEvolution Quarterly* ("simply a linear extension of the technological fix . . . I cannot see space trips in clunky, materialistic, tin-lizzie space ships as the means for embracing the cosmos. . .") softened her stand by admitting the possible validity of Barbara's assertion that the large-scale habitation of space could lead to increased synergy, empathy, and community among people all over the planet.

All the questions from the audience were directed to Barbara, an interesting barometer of the intellectual climate at NYU.

Those who wish to have Barbara lecture should contact the L-5 Society for

details. She is the author of *The Hunger of Eve: A Woman's Odyssey Toward the Future*, to be released this fall by Stackpole.

AIAA's GREY CALLS FOR ERDA BUDGET CHANGE

Jerry Grey, Administrator of Public Activities for the AIAA, has called for the amendment of ERDA's budget to include solar power satellite funding in fiscal '77.

In a report submitted to Senator Wendell Ford's (D-Kentucky) Subcommittee on Aerospace Technology and National Needs in response to an ERDA official's testimony, Grey stated:

"It was extremely encouraging to note that Dr. John Teem, in his testimony on January 21st, indicated for the first time ERDA's intention to 'give (satellite power systems) full consideration within the priorities of our overall solar energy program.'

"There are, however, two factors which tend to tarnish this promise somewhat. First, as I will comment further on later in this statement, ERDA has identified no FY 1977 budget for the satellite power concept, and since the Administration has concluded that NASA shall receive no direct funding for energy R&D, there appears to be no FY 1977 funding available for an SSPS program. Second, Dr. Teem resigned from ERDA subsequent to the January 21st hearing, and his position as ERDA's Assistant Administrator for Solar, Geothermal, and Advanced Energy Systems has been assumed (on an acting basis) by Robert L. Hirsch, a dedicated proponent of nuclear fusion. It will be interesting to see how much relative research emphasis will be given in future years to satellite solar power systems, which could be competitive with nuclear fusion in the same time frame, and which have far less uncertainty than fusion in both technical feasibility and projected system costs.

"An administrative quirk appears likely to generate an unnecessary and potentially expensive cessation of at least one year's duration in the SSPS research effort. As reported in Dr. Teem's testimony, the Administration has precluded NASA this year from funding any energy R&D; all budgetary responsibility for energy technology rests with ERDA. However, because ERDA did not agree to consider the SSPS concept as a future energy alternative until after its FY 1977 budget had been formulated, Dr. Teem has stated that no FY 1977 funds have been identified for the SSPS. With NASA out of the budget picture, the SSPS therefore "falls in the crack" for at least a year.

"However, it is clear that after about eight years of preliminary analyses, there now appears to be some substance to the space-based solar power concept, and, in fact, a modest acceleration in pace is

warranted in order to further define key problem areas and proceed with the definitive first phase of ground-based research. A year's unnecessary administrative budget moratorium could have serious effects on program momentum at this most critical juncture, and should the SSPS indeed turn out to be as promising a future energy option as is indicated by the testimony, considerable extraneous cost for alternative energy supplies could result from this unnecessary delay in system implementation by a year or more. It is therefore suggested that the ERDA FY 1977 budget be modified to include a modest but essential line item for SSPS research. If ERDA management deems it appropriate, funds could then be assigned to NASA for continuation and acceleration of existing efforts"

SLIDE SHOWS

The L-5 Society has an information packet available for those who wish to give nontechnical lectures. It includes a set of sixteen slides with written explanations of each slide, a copy of the preliminary report of the NASA-Ames Summer Study on Space Colonization, a summary of Mark Hopkin's "A Preliminary Cost-Benefit Analysis of Space Colonization," and copies of lectures given by Peter Vajk ("Outer Space and the Politics of Scarcity," Jay Huebner ("The Future"), Joe Haldeman ("Space to Grow In"-Joe has a story, "Tricentennial," which will appear in the July Issue of *Analog*, the first science-fiction story to elaborate on space colonization), and Keith Henson ("Solar Energy from Space").

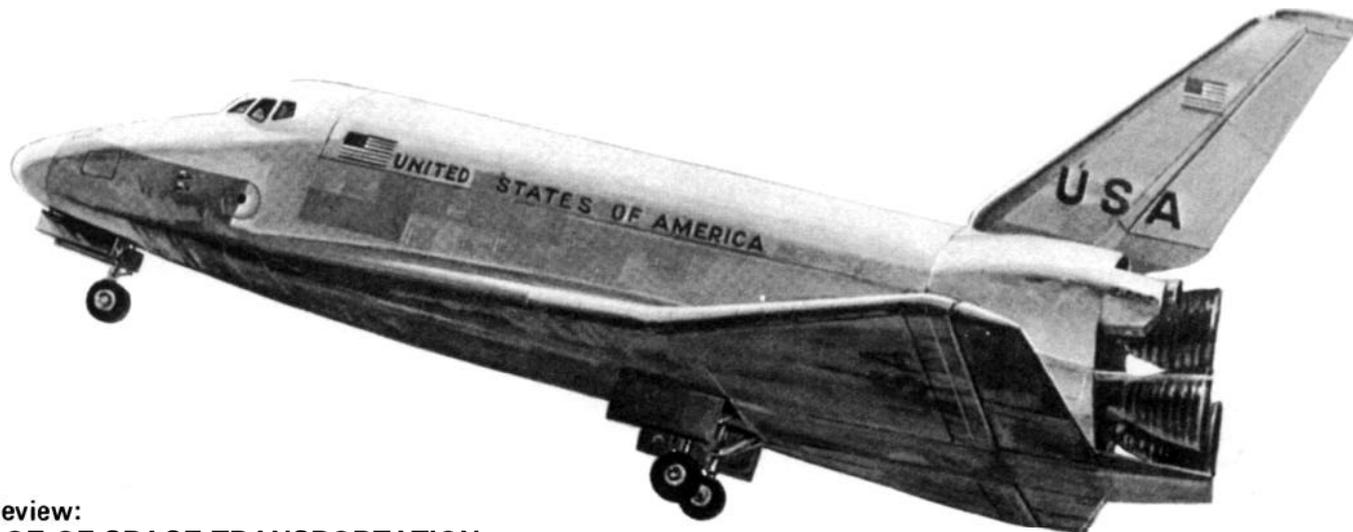
Reproduction and postage cost for the information packet is \$10.

Also available is a set of 32 slides suitable for a technical presentation. Reproduction and mailing cost is \$12. For a copy of the lecture information mentioned above, add \$4.

The L-5 staff apologizes for the delay in handling past requests for slides. Often, people have written in, promising to cover the expense of slides after they receive them. Unfortunately, the slide reproduction people won't let us have the slides until we pay for them. As a result, at times we have been unable to deliver slides due to lack of funds. To make matters worse, some people have been slow to reimburse the Society for its expenses.

In the future we will process prepaid slide request separately from the others. Non-prepaid orders will be saved to be processed when we get enough contributions to cover the reproduction bill. We can mail prepaid orders within two weeks.

Those interested in spaceoriented slides to add to their lectures should contact Dixon Space Scapes, P.O. Box 723, Rialto, California.



Film Review: THE AGE OF SPACE TRANSPORTATION

Carolyn Henson

"The Age of Space Transportation" is a twenty-minute color and sound film primarily concerning the Space Shuttle. While it is oriented toward general audiences, it can also be enjoyed by those who are more technically inclined.

The film is distributed free of charge by the AIAA. They request that you identify your group by letter, allowing at least thirty days to fulfill your request, to: Public Information Department, American Institute of Aeronautics and Astronautics, 1290 Avenue of the Americas, New York, NY 10019.

In their brochure on the film, the AIAA suggests that ". . . We should think seriously about putting up a permanent manned space station, an engineering

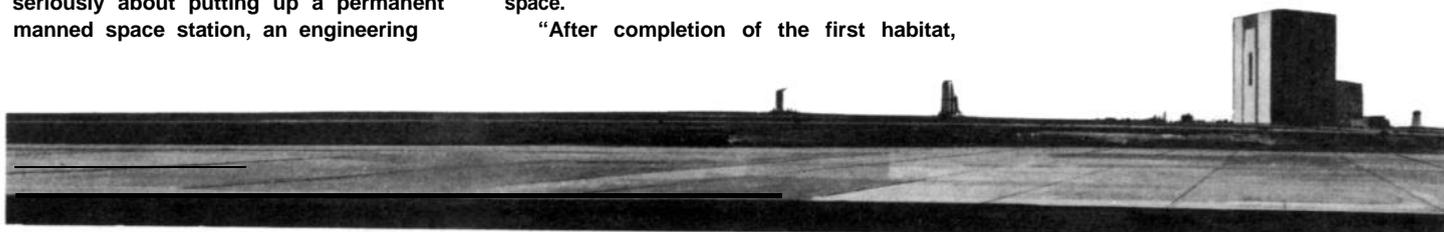
project that comes well within current technology.

"From such an engineering and operations station could grow, moreover, a space colony—a wheel-shaped habitat supporting up to 10,000 people along with shops, schools, light industry, and a self-contained agriculture system. The principal industry of such a colony would be manufacturing solar-energy collectors that would be placed in orbit near the Earth to beam down cheap energy. Solar energy also would power the space colony. Heavy industry would be conducted outside the habitat to make use of the weightlessness and vacuum of space.

"After completion of the first habitat,

larger colonies could be constructed, some orbiting farther from Earth. The asteroids, for instance, could supply construction material for colonies thousands of times greater in living space than all of Earth's continents."

"The Age of Space Transportation" ends on a breathtaking note, with exterior and interior views of the cylindrical O'Neill space colonies. This film can be used as an excellent lead-in to a lecture on space colonization, although it is admittedly a hard act to follow.



L-5 NEWS

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